MIXTURE DESIGN OPTIMIZATION OF THE FEEDING COMPOSITION IN ANAEROBIC DIGESTION

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Abstract

Large scale biogas plants are faced with insufficient amouts of substrates and are forced to use different mixtures of substrates for biogas production. The aim of this study was to select the best combionation of substrates from four different substrates and their blend ration in order to maximise methane production. For this experiment silo maize, dehydrated paper sludge from Paloma, Kraft sludge and OFMSW were used as substrates and co-substrates. Mesophilic batch experiments were made in triplicates (45 anaerobic reactors, 13 different combinations and glucose and negative controls) using upgraded 5 L. Organic loading in all casses was 10 g VS/l. Mathematical optimization of mixture was made by software STATISTICA (www.statsoft.com) (Mixture Design and triangulare surfaces) using method Simplex-lattice.

1. Results and discussion

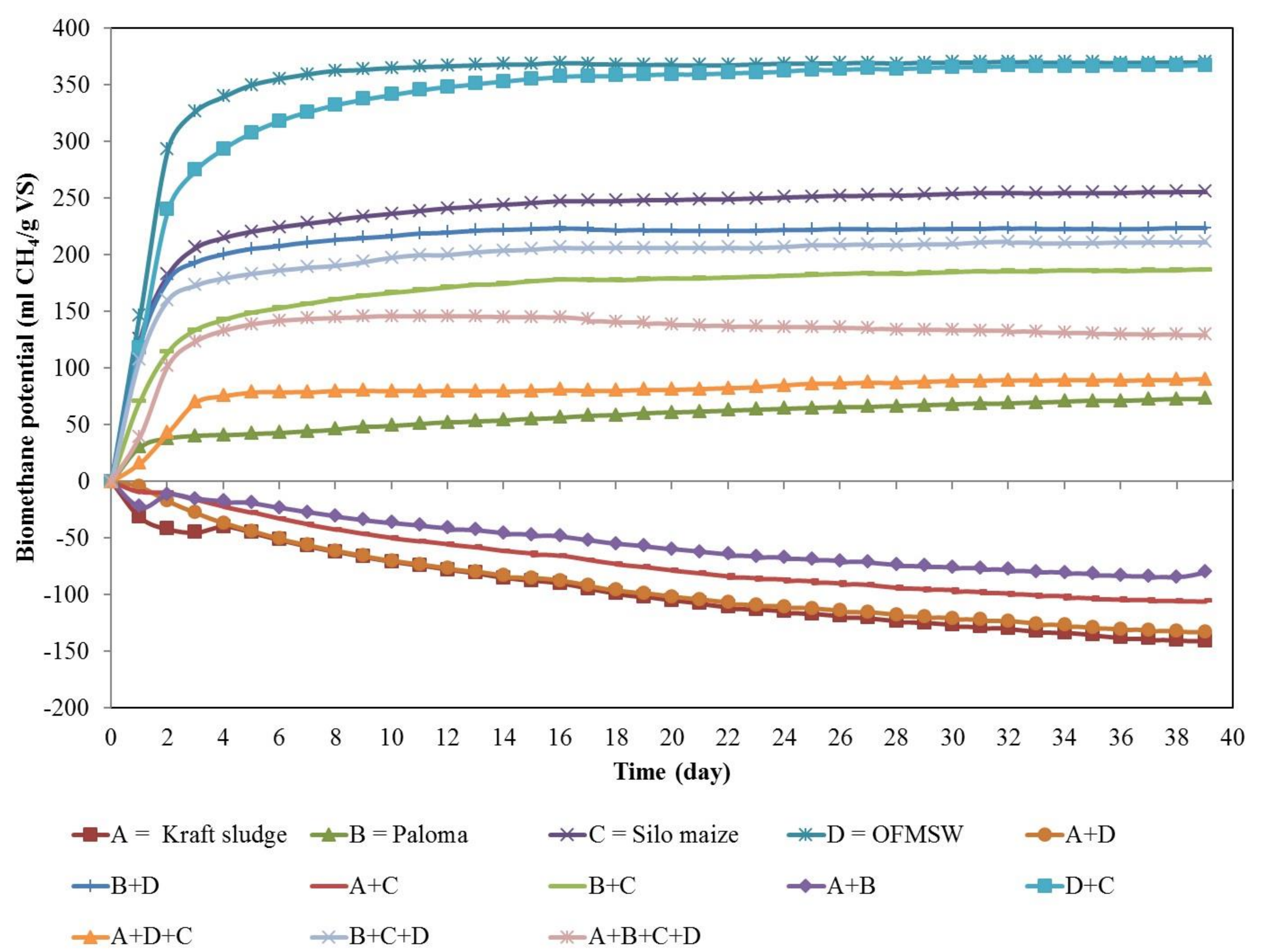

Figure 1: Acumulated methane produced as function of time from various combinations of dehydrated wastewater sludge from Kraft process (marked as A), dehydrated wastewater sludge from Paloma (marked as B), silo maize(marked as C) and OFMSW (marked as D) in codigestion process. The background methane produced from control (inoculum) was substracted generating negative values in inhibited reactors

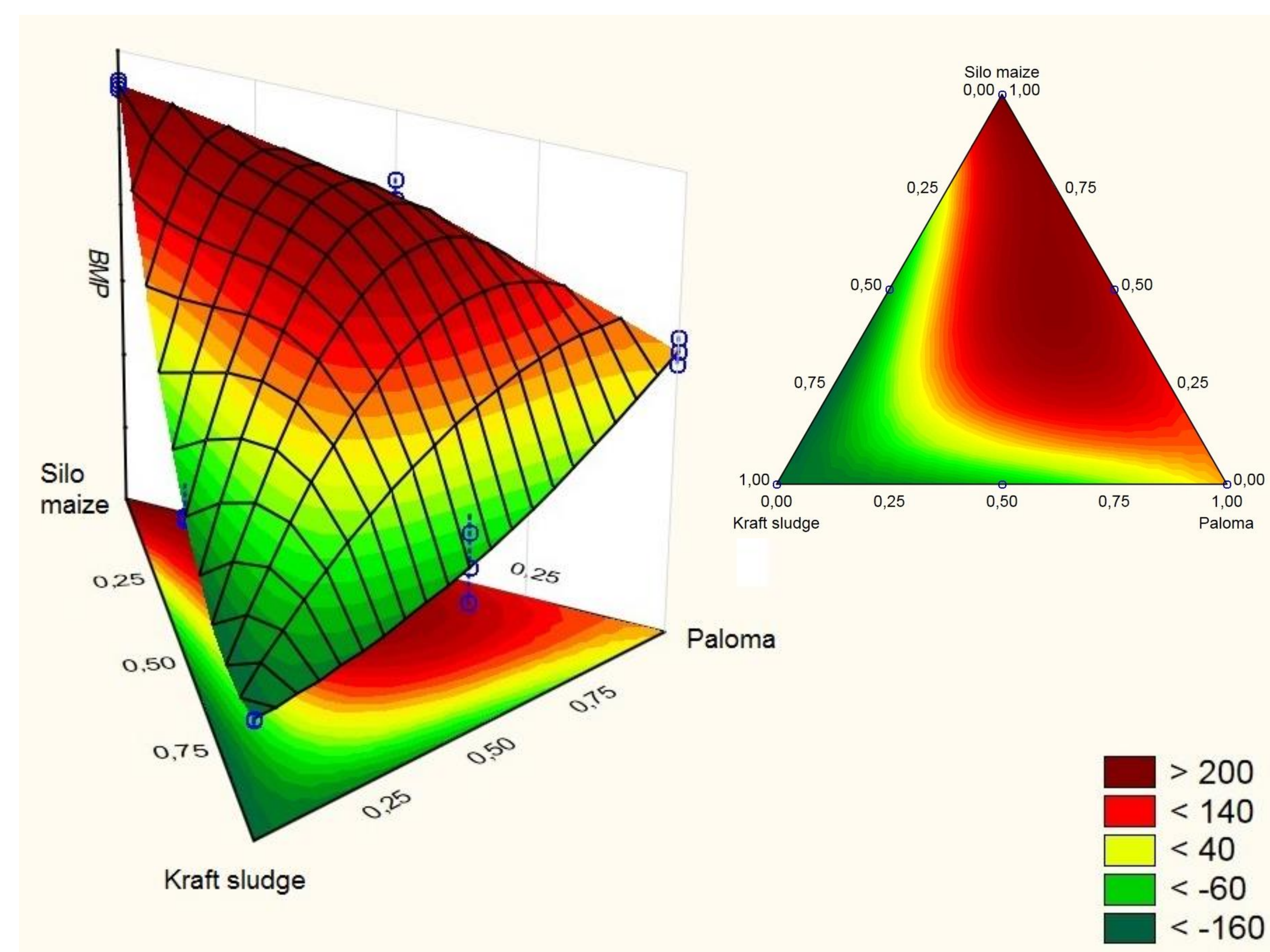

Figure 2: Mixture contour and surface plot of Biomethane potential (BMP) for different mixture of Kraft sludge, silo maize and OFMSW .

Table 1: Regression coefficient for linear and quadratic model for expected response of BMP of combinations paper sludge from Kraft process, silo maize and biological wastes.

Coefficient		Models – regression coefficients			BMP response	
		Linear	Quadratic	Special cubic	Measured	Predicted
(A) Kraft sludge	b_1	-264,813	-154,527	-140,40	-140,400	-140,400
(B) Paloma	b_2	94,576	70,674	73,50	73,500	73,500
(C) Silo Maize	b_3	252,253	248,728	256,47	256,100	256,467
(D) OFMSW	b_4	331,775	363,295	371,03	370,600	371,033
AB	b_{12}	-	-76,981	-184,60	-132,700	-132,667
AC	b_{13}	-	-456,881	-652,93	-79,600	-79,600
AD	b_{14}	-	-795,881	-991,93	-105,200	-105,200
BC	b_{23}	-	81,493	88,87	187,200	187,200
BD	b_{24}	-	-0,041	7,33	224,100	224,100
CD	b_{34}	-	295,926	214,87	367,300	367,467
ABC	b_{123}	-	-	5634,23	90,400	90,400
ACD	b_{134}	-	-	2346,90	212,00	212,000
BCD	b_{234}	-	-	-1518,20	146,100	146,233
p		0	0,00003	0,00003	-	-
R^2		0,822957	0,944773	0,981115	-	-
F		54,23	10,66	16,67	-	-

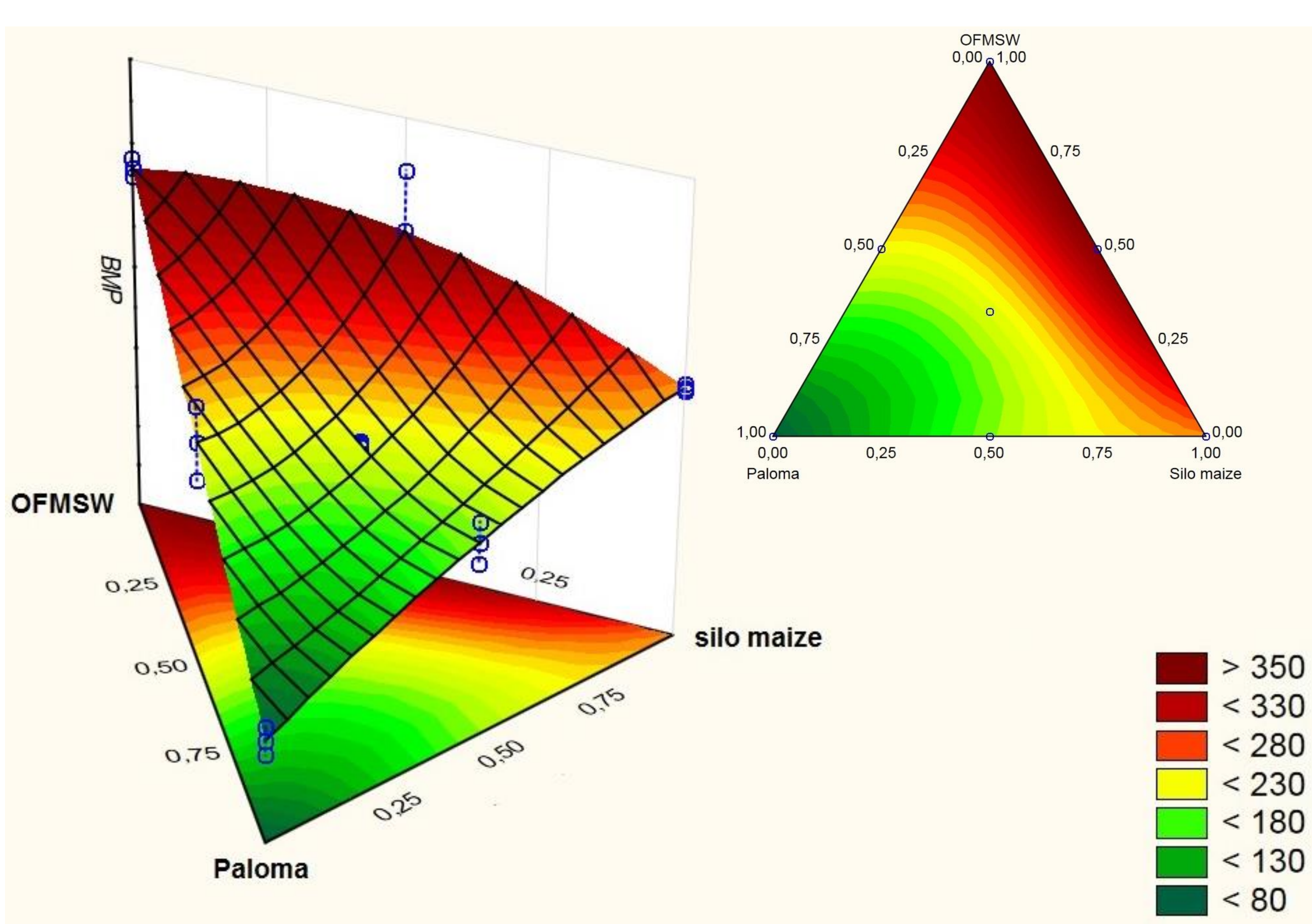

Figure 3: Mixture contour and surface plot of Biomethane potential (BMP) for different mixture of Paloma, silo maize and OFMSW .

2. Conclusions

The highest methane yield (371 ± 10,4 ml CH_4/g VS) was achieved by using silo maize as substrate. Inhibitory effect on methane production were noticed for Kraft sludge. Best combionation in co-digestion process (methaene yield 367 ± 72 ml CH_4/g VS) was made by OFMSW and silo maize. Best results in optimizing mixture of substrates was achieved in special cubic model for silo maize and OFMSW with best fit to measured results (R^2=0,981115) and statisticaly significant model (p < 0,05; F = 16).